



**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

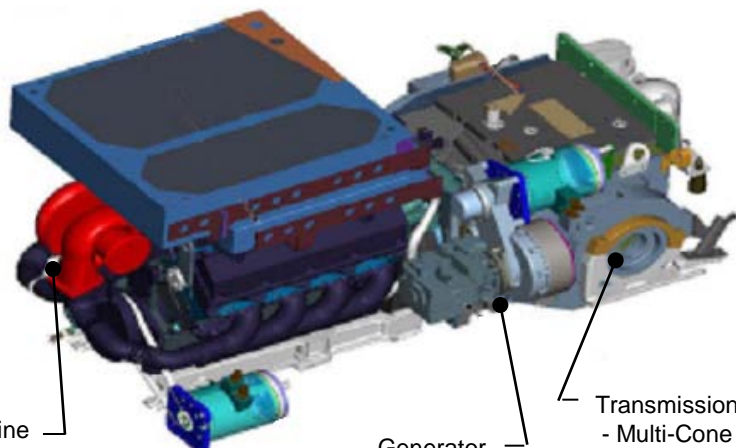
# GM Collaboration Powertrain Efficiency Programs

John Rzepecki

9 August 2010

UNCLASSIFIED: Dist A. Approved for public release

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE <b>09 AUG 2010</b>		2. REPORT TYPE <b>N/A</b>		3. DATES COVERED <b>-</b>	
4. TITLE AND SUBTITLE <b>GM Collaboration Powertrain Efficiency Programs</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) <b>John Rzepecki</b>				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>US Army RDECOM-TARDEC 6501 E 11 Mile Rd Warren, MI 48397-5000, USA</b>				8. PERFORMING ORGANIZATION REPORT NUMBER <b>21071</b>	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S) <b>TACOM/TARDEC</b>	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S) <b>21071</b>	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release, distribution unlimited</b>					
13. SUPPLEMENTARY NOTES <b>The original document contains color images.</b>					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>SAR</b>	18. NUMBER OF PAGES <b>10</b>	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			



Engine  
- Multiple fuels  
- Integrated Controls  
- Noise abatement

Generator  
- Hardware  
- Controls

Transmission  
- Multi-Cone clutches  
- Wide-spread, equally progressive gear ratios  
- Low parasitic oil mgmt.  
- Variator technologies  
- Integrated controls

### Payoffs:

- Improved vehicle mobility performance.
- Dramatically more electrical power available to meet future vehicle equipment demands.
- Improved engine power density on logistic fuel.
- Quieter engine idle to reduce vehicle acoustic signature during silent watch/mounted surveillance missions.
- Transitions to follow on ATO-D which will provide TRL 6 efficient powertrains to PM customers (HBCT, SBCT) by FY17

### Purpose:

Provide efficient, reliable powertrain technologies that will improve the energy productivity of existing military ground vehicle engine-transmission while using less space, improving vehicle mobility, fuel consumption and reducing thermal load.

### Products:

- Highly integrated, fuel efficient powertrain achieving a TRL 5.
- Next-generation, binary logic based transmission technologies improving energy productivity and lowering system parasitic losses.
- Innovative engine controls that will seamlessly adapt to a range of military fuels with no power degradation.
- Electrical power generation sources integrated into the powertrain to provide enough power for all planned future non-mobility power demands
- Acoustic signature reduction technologies to quiet main engine at idle to address future silent watch requirements.



# Efficient Powertrain Technologies Powertrain Programs



## 3 BAA Topics for Powertrain Systems

- 7 to 9 ton
- 15 to 19 ton
- 20 to 40 ton

### Program Metrics

#### Engine

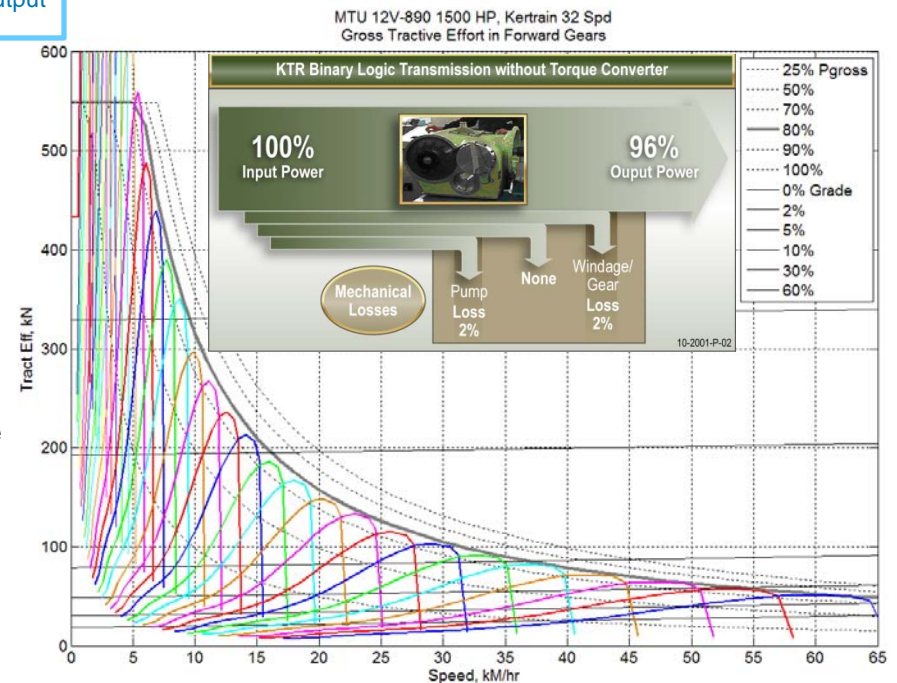
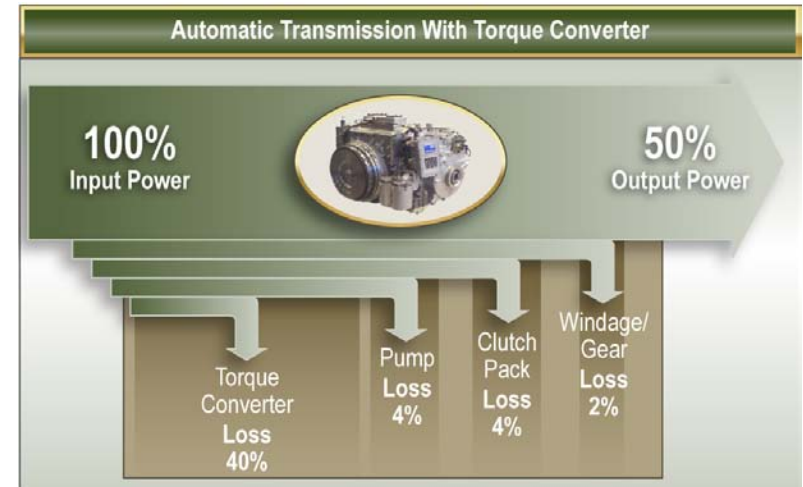
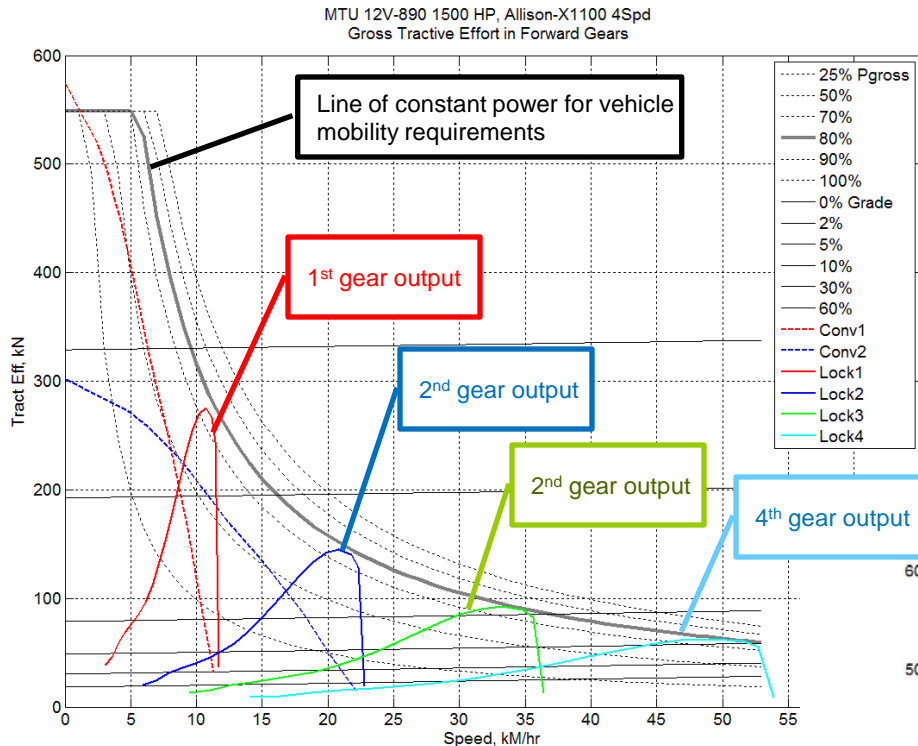
Thermal Efficiency	44% or greater
Heat rejection	0.6 kW/kW or less
Emissions	No Aftertreatment nor EGR; must conform to 1998 emissions standards
Power	150 to 300 Hp
Fuel Compatibility	DF-2, ULSD, JP-8, JP-5, Jet-A, and mixture

#### Transmission

Configuration	Automatic Longitudinal or Cross Drive (20-40 ton)
Ratio spread	Greater than 10.0
Transmission Efficiency	90% or greater

#### Generator

Electrical Power Generation	85kW continuous	150 kW (20-40 ton)
Generator Output Voltage	350 – 600 Volts DC	

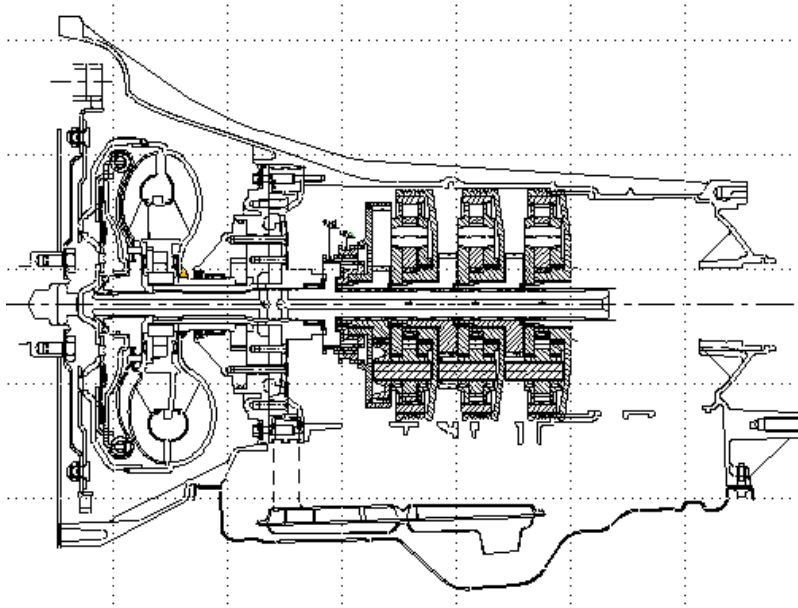


### The Binary Logic Transmission features:

- Eliminating the torque converter
- Utilizes multiple gears in various combinations to achieve the desired gear ratio for maximum efficiency, 20:1 to 100:1 or more
- High efficiency, > 90%
- Enables optimum engine performance and efficiency
- Reduces cooling requirements
- 30-40% less volume/size, weight and parts

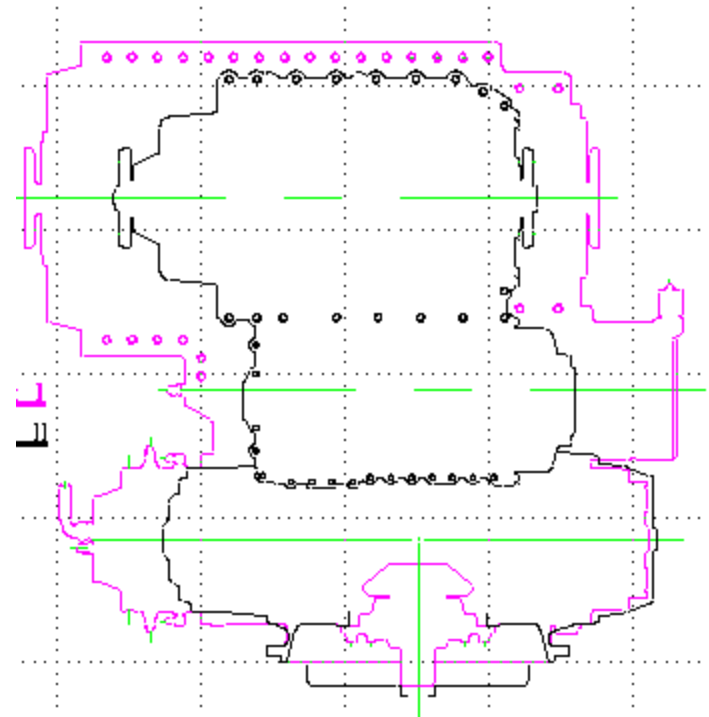
- Incrementally Variable Transmissions
- Infinitely Variable Transmissions
- Launch Clutches
- Torque Converters
- Transfer Cases
- Controls Strategies
- Clutch systems
- Differentials
- PTO Gearing



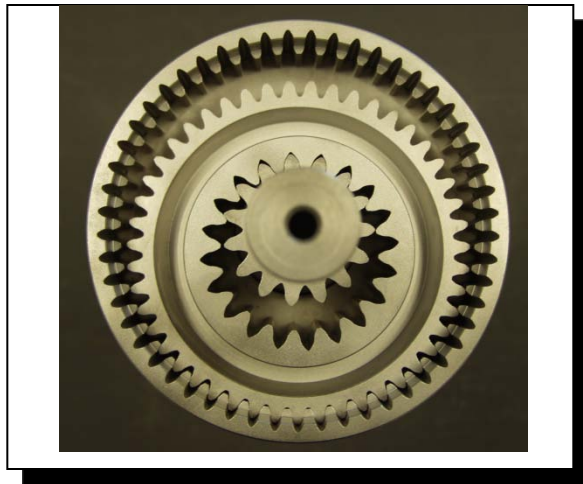


Longitudinal Application

Cross Drive Application



- Substitute for a planetary gear set
- Specifics in size and through torque is twice that of a planetary
- A 50/50 torque split differential is achievable
- Different DP's between the Pinion/Cluster and Cluster/Annulus is achievable
- High tooth contact
- Quiet operation
- Reduced gear tooth speeds
- Patented addendum contact tooth profile





## Binary Logic Transmissions

- 32 forward and reverse speeds with only 5 gear sets
- High tooth contact ratio (up to 16)
- No torque converter
- Reduction ratio 20:1
- High efficiency, > 90%
- Precise mechanical steering, no slippage
- Electronic Shift Control
- Reduced cooling needs

## Variator Advantages:

- High Efficiency (+94%) throughout range
- Full engine braking
- Smaller package
- Reduced Weight
- No horsepower restrictions (scaleable design)
- Full range from 0 to  $\pm 1$
- Adaptable to fit existing transmission envelopes

## Efficiency Curve Trends:

